SOFA AND METHOD OF MANUFACTURING SAME

Cross-Reference to Related Application

The present application claims priority from U.S. Provisional Patent Application Serial No. 60/490,387, filed 25 July 2003, the disclosure of which is hereby incorporated herein in its entirety.

Field of the Invention

The present invention relates generally to furniture, and more particularly to seating units and their methods of manufacture.

Background of the Invention

A typical sofa includes a deck or seating surface for supporting a seated occupant, a backrest that is attached to the rear edge of the deck and rises upwardly therefrom, and arms attached to the lateral edges of the deck. Conventionally, an upholstered sofa is constructed by first forming an internal frame (usually made of wood) that provides the general shape of the sofa. The frame includes the underlying portions of the deck, backrest, and arms. In some instances inserts (typically formed of a soft foam) will be attached to the wooden frame. A deck fabric is stretched across the deck to provide support for seating, and in some instances, springs or other resilient members will be positioned below the deck fabric. This frame is then covered with upholstery that is typically tacked or stapled to the frame, with separate pieces of upholstery being attached for each arm and for the back and deck. Many sofas will also include a separate dust cover that covers the underside of the deck and is stapled or tacked to the frame. Subsequently, additional features such as feet, adornments and the like are attached to the upholstered sofa. Finally, cushions are typically added to cover the backrest and deck; these cushions may be removable or permanently attached.

Although the foregoing represents a conventional manufacturing technique, there are some shortcomings. Stapling the deck fabric, upholstery and/or dust cover into place can be relatively time-consuming, thereby increasing labor costs. Also, the attachment of the arm upholstery can be somewhat burdensome, particularly at the joints between the arms and the

back and deck. Further, if the upholstery is a relatively thick material, such as leather, the presence of seams and folds in the upholstery may render the attachment of the feet and other ornamental features difficult. As such, alternative techniques for manufacturing sofas may be desirable.

Summary of the Invention

The present invention is directed to subassemblies and manufacturing methods for sofas that can improve manufacturing efficiency and product quality. As a first aspect, embodiments of the present invention are directed to a backrest and deck subassembly for a sofa. The subassembly comprises: a frame having a generally horizontal deck section, the deck section including a top portion and an underlying bottom portion, the frame also having a generally upright backrest section attached to and extending upwardly from the deck section; and an integrated upholstery piece that covers the deck and backrest portions of the frame and underlies the bottom section of the deck portion. The integrated upholstery piece can reduce manufacturing time by eliminating the need to separately attach the upholstery and dust cover. In some embodiments, the upholstery piece includes a zipper that can markedly facilitate enclosing of the frame within the upholstery piece.

As a second aspect, embodiments of the present invention are directed to another backrest and deck subassembly for a sofa. In these embodiments, the subassembly comprises: a frame having a generally horizontal deck section, the deck section including a top portion, the frame also having a generally upright backrest section attached to and extending upwardly from the deck section, the deck section top portion having front and rear laterally-extending slots; a deck fabric sheet; and a pair of slats attached to the deck fabric sheet, the slats being received in the front and rear slots of the deck section top portion. This configuration can simplify and expedite installation of a deck fabric over the deck section, and can do so while producing a taut deck fabric. Embodiments of this aspect of the invention may also include those in which the deck fabric sheet is attached to an upholstery piece (like that discussed above) that substantially covers the frame.

As a third aspect, embodiments of the present invention are directed to a sofa, comprising: a backrest and deck subassembly comprising a frame having a deck section and a backrest section, the frame including lateral surfaces with inwardly-extending recesses; and a pair of arm units, each of the arm units including hooks configured to fit within the recesses

of the frame to connect the arm units thereto. This configuration enables the back and deck subassembly and the arm units to be constructed and upholstered separately, then brought together to form the final sofa unit.

As a fourth aspect, embodiments of the present invention are directed to an arm unit for a sofa, comprising: a frame having a bottom surface, the bottom surface having front and rear recesses; an upholstery piece that covers the frame bottom surface; and front and rear feet that are attached to the upholstery piece to underlie the front and rear recesses. The presence of the recesses can enable the feet to be placed precisely. In some embodiments, seam channels are present in the recesses to receive seams from the upholstery and improve mounting of the feet.

As a fifth aspect, embodiments of the present invention are directed to a method of constructing a sofa. The method comprises the steps of: applying a unitary back-deck upholstery piece to a back-deck frame of a sofa, the upholstery piece substantially enclosing the back-deck frame, to form an upholstered back-deck unit; applying a respective unitary arm upholstery piece to each of two arm frames, the upholstery pieces substantially enclosing the arm frames, to form upholstered arm units; and attaching the upholstered arm units to the upholstered back-deck unit to form a fully upholstered sofa. In some embodiments, it may be advantageous for the back-deck and arm units to incorporate aspects of embodiments of the invention discussed above.

Brief Description of the Drawings

Figure 1 is a schematic diagram illustrating an embodiment of a method of constructing a sofa according to the present invention.

Figure 2 is a rear perspective view of the back-deck frame of the sofa of **Figure 1** without backrest straps and a deck suspension unit.

Figure 3 is an enlarged front perspective view of the back-deck frame of **Figure 2** with a top edge insert cap being installed.

Figure 4 is a disassembled plan view of an upholstery blank for the upholstery piece to cover the back-deck frame of **Figure 2**.

Figure 5 is an enlarged partial perspective view of the upholstery piece of **Figure 4** illustrating insertion of slats into pockets in the upholstery piece.

Figure 6 is a greatly enlarged partial perspective view of the upholstery piece of **Figure 5** being installed over the back-deck unit of **Figure 2**.

Figure 7 is a bottom perspective view of the upholstery piece of **Figure 5** being zipped over the back-deck unit of **Figure 2**.

Figure 8 is a perspective view of a fully upholstered back-deck unit of the sofa of **Figure 1**.

Figure 9 is a bottom view of an arm frame of the sofa of **Figure 1** showing recesses and channels formed therein.

Figure 10 is a disassembled plan view of an upholstery blank for the upholstery piece to cover the arm frame of **Figure 9**.

Figure 11 is a perspective view illustrating the application of the upholstery piece of **Figure 10** over the arm frame of **Figure 9**.

Figure 12 is an enlarged partial bottom view of the arm frame of **Figure 9** covered with the upholstery piece of **Figure 10** showing how seams of the upholstery piece reside within the seams channels of the arm frame.

Figure 13 is a bottom perspective view of the assembly of a fully upholstered arm unit of **Figure 12** to the fully upholstered back-deck unit of **Figure 8**.

Figure 14 is a greatly enlarged bottom perspective view of front portions of the arm unit and back-deck frame of **Figure 13** showing how the front portion of the arm unit is secured with a threaded fastener to the front portion of the back-deck frame.

Detailed Description of Embodiments of the Invention

The present invention will be described more particularly hereinafter with reference to the accompanying drawings. The invention is not intended to be limited to the illustrated embodiments; rather, these embodiments are intended to fully and completely disclose the invention to those skilled in this art. Like numbers refer to like components throughout, and certain dimensions and thicknesses may be exaggerated for clarity. It will be understood that when an element is referred to as being "attached", "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly attached," "directly connected" or "directly coupled" to another element, there are no intervening elements present.

The present invention is directed to a sofa having a seat and backrest that form a seat-back deck unit and arms attached on either end thereof. As used herein, the terms "forward", "front" and derivatives thereof refer to the direction defined by a vector extending from the backrest toward the seat parallel to the underlying surface. Conversely, the terms "rearward" and derivatives thereof refer to the direction directly opposite the forward direction; i.e., the rearward direction is defined by a vector that extends from the seat toward the backrest parallel to the underlying surface. The forward and rearward directions together comprise the "longitudinal" directions relative to the sofa. The terms "outward," "lateral", and derivatives thereof refer to the direction defined by a vector originating in the center of the seat and extending toward the arms in the plane of the underlying surface and perpendicular to the forward and rearward directions. The terms "inboard", "inward" and derivatives thereof refer to the direction directly opposite to the lateral direction as defined hereinabove. The outward and inward directions together comprise the "transverse" directions relative to the chair.

Referring now to the figures, a method of constructing a sofa (designated broadly at **20**) is illustrated in **Figure 1**. In general terms, the sofa **20** is constructed based on two independent manufacturing paths that produce subassemblies that then are combined into the final sofa product. In the first path, two upholstered arm units **60** are produced. Each arm unit **60** begins with a skeletal frame **50** having two protruding hooks **58**. As a first step, recesses **52** are formed in the bottom plank of the arm frame **50**. The arm frame **50** is then substantially enclosed within a single arm upholstery piece **54**. The upholstery piece **54** includes windows **55** on an inwardly-facing surface through which the hooks **58** protrude. This process produces two upholstered arm units **60**.

In the second manufacturing path, a skeletal back-deck frame **22** with deck and back sections **24, 26** is employed (the deck section **24** is the portion of the frame **22** that provides support for a seated occupant). An insert cap **32** that fits onto the top of the back section **26** is attached. A single back-deck upholstery piece **40** is then applied to the back-deck frame **22** such that it substantially encloses the back-deck frame **22** to form an upholstered back-deck unit **44**.

At this point the two manufacturing paths merge, as the upholstered arm units **60** are attached to the upholstered back-deck unit **44**. The hooks **58** of the arm units **60** are placed within receptacles **46** in the lateral edges of the upholstered back-deck **44** (access to the receptacles **46** is available due to the presence of windows **95** in the upholstery piece **40**).

The arm units **60** are further secured to the back-deck unit **44** with threaded fasteners to produce the sofa **20**. Finally, feet **62** are mounted under the recesses **52** and the portions of the upholstery piece **54** that underlie them.

The above-described steps and materials are described in greater detail below, with reference to the remaining figures.

Figure 2 illustrates the back-deck frame **22**, which, as noted above, includes a deck section **24** and a back section **26**. The frame **22** as illustrated is formed of a number of wooden planks and boards that are fixed to one another define the outline of a sofa. Side boards **26a, 26b** form the sides of the frame **22**; the side boards **26a, 26b** include receptacles **46** that are generally vertically aligned. Front and rear rails **26c, 26d** span the front and rear portions of the side boards **26a, 26b** to define the surface of the deck section **24**. A lower front rail **26e** spans the lower front corners of the side boards **26a, 26b**, and a lower rear rail **26f** spans the lower rear corners of the side boards **26a, 26b**. A top rail **26g** spans the top rear portion of the side boards **26a, 26b**. Internal support boards **26h, 26i** are positioned intermediate of the side boards **26a, 26b** to support the aforementioned rails. Flanges **29a, 29b** are attached to and extend laterally from the rear edges of the side boards **26a, 26b**. Ears **29c, 29d** are mounted to the upper lateral edges of the flanges **29a, 29b**. The gap between the ears **29c, 29d** and their adjacent side boards **26a, 26b** may be covered with chip board, masonite or some other material.

Horizontal straps **28** (typically formed of a flexible fabric – *see* **Figure 1**) extend between the side boards **26a, 26b** of the frame **22** to define the forward surface of the back section **26**. A deck suspension unit **31** (for example, sinuous or coil springs, webbing sheets or straps, or the like - *see* **Figure 1**) spans the area between the side boards **26a, 26b** and the front and rear rails **26c, 26d** to define further the upper surface of the deck section **24**. A transversely-extending front slot **25a** is present in the front rail **26c**, and a similar transversely-extending rear slot **25b** is present in the rear rail **26d** (*see* **Figure 2**). The front and rear slots **25a, 25b** are configured such that they have open upper ends that flare outwardly from one another (i.e., the upper end of the slot **25a** faces slightly forwardly and the upper end of the slot **25b** faces slightly rearwardly – best seen in **Figure 6**).

Those skilled in this art will appreciate that the frame **22** can take many forms other than that illustrated and described herein. For example, the frame **22** may be constructed of different materials, may have additional or fewer rails than those shown herein, or may lack

the slots and receptacles discussed above. As another example, the deck suspension unit **31** may be omitted entirely. Other variations will also be apparent to those skilled in this art and need not be described in detail herein.

Referring now to **Figure 3**, the installation of the top edge insert cap **32** is illustrated therein. As can be seen in **Figure 3**, the top edge insert cap **32** has a substantially constant, generally L-shaped cross-section, such that the cap **32** fits over the top surface and front edge of the top rail **26g** and provides the profile of the top portion of the sofa **20**. The cap **32**, which is typically formed of a flexible, expanded polyethylene foam (preferably extruded), is stapled or otherwise fastened into place on the top rail **26g** and the internal support boards **26h, 26i**. Notably, the shape of the cap **32** assists it to remain in place, and formation of the cap **32** via extrusion can reduce its cost and repeatability significantly.

Once the top edge insert cap **32** is installed, padding sheets (typically the padding sheets are formed of ¼ to 1 inch urethane foam or batted polyester fiber or similar material) are laid over the straps **28**, the top edge insert cap **32** and the upper region of the rear side of the back section **26** (including the ears **29c, 29d**) and stapled into place (this step is not illustrated in the drawings). Those skilled in this art will appreciate that other materials may be employed in place of the fiber sheets, and that the fiber sheets may be omitted entirely.

Referring now to **Figures 4-8**, the next step in the construction of the back-deck unit **44** is the enclosing of the back-deck frame **22** with the back-deck upholstery piece **40**. This step can include multiple substeps, some of which are described below.

Referring first to **Figure 4**, the back-deck upholstery piece **40** is a single integrated piece of upholstery that is created from multiple panels that are sewn together as a back-deck upholstery blank **80** prior to installation of the upholstery piece **40** on the back-deck frame **22**. The back-deck blank **80** includes a series of front panels **82** that overlie the front surface of the frame **22**. A deck panel **84** shares a seam with the front panels **82** and overlies the deck surface of the frame **22**. A backrest panel **86** shares a seam with the deck panel **84** and overlies the backrest surface of the frame **22**. Multiple top panels **88** are sewn to the backrest panel **86** to cover the top of the back section **26** of the frame **22**, and multiple back panels **92** share a seam with the top panels **88** and cover the rear surface of the back section **26** (including the flanges **29a, 29b**). Two ear panels **90** are sewn to the lateral edges of the backrest panel **86** and the lateralmost top panels **88**, and are also sewn to rear flange panels **93**, which also share a seam with the lateralmost back panels **92**. L-shaped front lateral

panels **94** (only one is shown in **Figure 4**) share a seam with the rear flange panels **93**, and are also sewn to the lateral edges of the backrest panel **86**, the deck panel **84**, and the front panels **82**. A dust cover panel **96** shares a seam with the back panels **92** and an opposite seam with the lower edges of the front panels **82**, and its lateralmost edges are sewn to the bottom edges of the rear and front lateral panels **93, 94**.

A transversely-extending zipper **98** is included in the front region of the dust cover panel **96** and extends to the edges thereof. A zipper **99** follows a somewhat serpentine path rearwardly along the lower portion of each rear front panel **94**, then veers upwardly to terminate near the top of the front lateral panel **94**; in doing so, the zipper **99** passes between two windows **95** in the lateral panel **94** that are generally vertically aligned and are positioned to provide access to the receptacles **46** in the side boards **26a, 26b** of the frame **22**.

In the illustrated embodiment, the front panels **82**, the top panels **88**, the ear panels **90**, and the rear flange panels **93** are formed of leather, the dust cover panel **96** is formed of a heavy non-woven fabric, and the remaining exterior panels are formed of an air permeable non-woven fabric. Of course, these materials may vary in other embodiments of the sofa.

Those skilled in this art will recognize that other upholstery configurations may be suitable for use with the present invention. For example, different numbers and shapes of panels may be employed, or some panels that are illustrated herein may be combined or divided as desired. In addition, other reversible fasteners, such as snaps, hook-and-loop material, and the like may be employed in place of the zippers. It is preferred that the upholstery for the frame **22** be formed as a single integrated piece that is installed as a single unit.

As can be seen in **Figure 4**, the upholstery blank **80** also includes a front pocket panel **100** that is folded lengthwise and sewn on the seam shared by the front panels **82** and the deck panel **84**. Once sewn, the front pocket panel **100** forms a front pocket **101**. A rear pocket panel **102** is folded lengthwise and sewn on the seam shared with the deck panel **84** and the backrest panel **86** to form a rear pocket **103**. Preferably, the front and rear pocket panels **100, 102** are sewn simultaneously with the sewing of the aforementioned seams they share. Also, in the illustrated embodiment a padding panel **108** is sewn to the rear surface of the front panels **82** (**Figure 6**) to provide cushioning and contour thereto. One or more padding sheets (not shown) may also be included beneath the deck panel **84**.

Figures 5-7 illustrate the covering of the back-deck frame **22** with the upholstery piece **40**. Referring first to **Figure 5**, wooden slats **104, 106** are inserted into the front and rear pockets **101, 103** in the upholstery piece **40**. The upholstery piece **40** is then lifted over the top of the back section **26** of the back-deck frame **22**. The pocketed slats **104, 106** are then slipped into, respectively, the front and rear slots **25a, 25b** of the front and rear rails **26c, 26d (Figure 6)**. The orientation of the slots **25a, 25b** (i.e., with their open upper ends flared away from each other) causes the deck panel **84** to be pulled taut. This step can provide a taut deck surface without substantial stapling or other securing of a deck fabric (as would typically be the case for prior sofas), thereby simplifying and expediting the installation of the deck surface.

Referring again to **Figure 6**, the front edge insert cap **30** is illustrated therein. Like the top edge insert cap **32**, the front edge insert cap **30** is typically formed of a flexible expanded polyethylene foam material, and is of substantially constant cross-section. The front edge insert cap **32** includes a finger **31** that extends into the front slot **25a** in the front rail **26c**; the remainder of the front edge insert cap **30** extends forwardly therefrom to overlie the front rail **26c**. Once the front edge insert cap **30** has been installed, the front panels **82** of the upholstery piece **40** can be positioned over the front edge insert cap **30** and draped over the front surface of the deck section **24**. The front edge insert cap **30** and the padding panel **108** may be secured to the frame **22** with staples or other fasteners.

Referring now to **Figure 7**, once the front edge insert cushion **30** has been installed and the front panels **82** have been positioned, the back-deck upholstery piece **40** can be slipped over the remainder of the frame **22**. After the upholstery piece **40** is secured in place with a few staples, the zippers **99** can be zipped from their upper points on the front lateral panels **94** to their termination points near the dust cover panel **96**. The zipper **98** can also be zipped to complete the upholstering of the frame **22**.

Once the back-deck upholstery piece **40** has been installed on the frame **22**, the construction of the upholstered back-deck unit **44** is complete (*see* **Figure 8**). It can be joined with two upholstered arm units **60**, the construction of one of which is described below.

Referring back to **Figure 1**, the arm frame **50** includes a top plank **50a**, a bottom plank **50b**, and front, intermediate and rear planks **50c, 50d, 50e** that together form a box-type skeletal frame. An external side board **50f** is attached to the lateral edge of the rear

plank **50e** and extends rearwardly therefrom. A mounting gusset **50g** is fixed to the inward side of the top and front planks **50a, 50c**. The aforementioned hooks **58** extend inwardly and upwardly from the rear plank **50e**.

Referring now to **Figure 9**, it should be noted that the underside of the bottom plank **50b** includes recesses **52**. The recesses **52** are typically about 1/8 inch in depth and sized to match the length and width of the feet **62**. The recesses **52** may be formed in any manner known to those skilled in this art for forming such topography, including routing. Also, seam channels **53** are located at each corner of the bottom plank **50b** and extend diagonally within the recesses **52**.

Referring now to **Figure 10**, the arm upholstery piece **54** is a single integrated unit of upholstery that is created from multiple panels that are sewn together as an arm upholstery blank **110** prior to installation of the upholstery piece **54** on the arm frame **50**. The arm upholstery blank **110** includes multiple lateral panels **112**, a top panel **114** that is sewn to the top edges of the lateral panels **112** and a front panel **116** that shares a seam with the top panel **114** and another seam with the forwardmost lateral panel **112**. Multiple upper inner panels **118** are sewn to the inward edge of the top panel **114**, and a front inner panel **121** is sewn below the front upper inner panel **118**. The blank **110** is completed with a main inner panel **120** that is sewn to the upper inner panels **118** and the front inner panel **121**. The main inner panel **120** includes a cutout area **122** at its lower rear corner to enable flaps formed thereby to meet and share lower and rear seams with the lateral panels **112**. The main inner panel **120** also includes windows **124** that are configured and arranged to receive the hooks **58** of the arm frame **50**, and a window **130** that is configured to receive a securing bolt. The main inner panel **120** further includes an L-shaped zipper **126** that commences at the top rear edge of the main inner panel **120**, travels downwardly therefrom rearward of the windows **124**, and extends forwardly to terminate at the front edge of the main inner panel **120**.

In the illustrated embodiment, the main inner panel **120** is formed of an air permeable non-woven fabric, and the remaining panels of the upholstery piece **60** are formed of leather. However, those skilled in this art will recognize that these materials may vary as desired. Also, as is the case with the back-deck upholstery piece **40**, those skilled in this art will recognize that other configurations of the upholstery piece **54** may be suitable for use with the present invention. For example, different numbers and shapes of panels may be employed, or some panels that are illustrated herein may be combined or divided as desired.

In addition, other reversible fasteners, such as snaps, hook-and-loop material, and the like may be employed in place of the zippers. It is preferred that the upholstery for the frame **50** be formed as a single integrated piece that is installed as a single unit.

Referring now to **Figure 11**, the arm upholstery piece **54** can be slipped over the arm frame **50** (for example, beginning at the lower front portion of the frame by hooking the upholstery piece **54** over the bottom plank **50b**). In some embodiments, padding sheets or other cushioning materials are attached to portions of the arm frame **50** prior to covering the frame **50** with the upholstery piece **54**. The upholstered arm unit **60** can then be completed by zipping the zipper **126** to substantially enclose the arm frame **50** with the arm upholstery piece **54** (*see* **Figure 12** for illustration of the upholstered arm unit **60**). In the illustrated embodiment, seams from the upholstery piece **54** reside within the seam channels **53**.

Referring now to **Figures 13** and **14**, once the upholstered arm units **60** have been completed, they can be attached to the upholstered back-deck unit **44**. The upholstered arm units **60** are interconnected with the upholstered back-deck unit **44** by first inserting the hooks **58** into the receptacles **46** in the back-deck frame **22** (*see* **Figure 13**). Engagement of the hooks **58** with the receptacles **46** places the rear surface of the upholstered arm unit **60** in contact with and in front of the forward surface of the flange **29a**. A threaded fastener (for example, a bolt) can be inserted through the side board **26a** and into a receiving aperture in the gusset **50g**. Access to the side board **26a** is available via the zipper **98**, which can be unzipped sufficiently to enable an operator to reach the side boards **26a**, then re-zipped after the fastening operation is complete.

Referring now to **Figure 1**, the feet **62** can be attached to the bottom surface of the bottom plank **50b**. Positioning of the feet can be facilitated by the presence of the recesses **52**. Also, the presence of the seam channels **53** can provide a relief area for the seam in the arm upholstery piece **54** that might otherwise interfere with flush mounting of the feet **62**. This seam can be rather thick, particularly if a thick material such as leather is used with the upholstery, so reception of seams within the seam channels **53** can improve the precision of the mounting of the feet **53**.

Those skilled in this art will appreciate that other finishing operations, such as additional stapling or fastening of components (for example, securing of the zipper slides), may also be desirable for the sofa **20**. Typically, additional seat, armrest and/or backrest

cushions will be employed with the sofa **20**, although these may be omitted as desired. Also, additional ornamentation (such as studs, inlays, and the like) may also be included.

The sofa and manufacturing method of the present invention can offer some advantages over prior sofas. First, the separate upholstering of the back-deck frame and the arm frames can significantly simplify the upholstering process. The use of single upholstery pieces to substantially enclose the back-deck and arm frames can markedly reduce the amount of labor required to fully upholster these components. The use of a zipper or other reversible fastener to complete enclosure of the frame can further facilitate this process. Second, the inclusion of a dust cover that is integrated with the remainder of the back-deck upholstery eliminates the attachment of the dust cover as a separate step. Third, the use of slats and slots to mount the deck fabric taut on the frame can reduce labor considerably, particularly when the deck fabric is integrated with the remainder of the back-deck upholstery. Fourth, the inclusion of the hooks in the arm units can facilitate attachment of the arm units (particularly as they are already upholstered) and in embodiments in which the hooks extend upwardly, the weight of the back-deck unit and any occupants further secure the arm units in place. Fifth, the inclusion of the finger in front edge insert cushion enables it to be installed quickly. Sixth, the presence of the recesses on the arm units helps to align the feet, even if a thick upholstery material such as leather is used, and the presence of the seam channels within the recesses can enable the feet to fit flush against the recesses.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. As such, all such modifications are intended to be included within the scope of this invention. The scope of the invention is to be defined by the following claims.